Space Weather Technical Forecast

Issued on Tuesday, 08 November 2022 at 01:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active fluence (1e8 integrated pfu) dropping off today. Chance of M-class flares (R1; Minor radio blackouts) throughout. Very slight chance of G1/Minor storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with several C-class flares observed in the past 24 hours, and at 07/0011UTC a single M-class flare was recorded originating from sunspot AR3141. There are six numbered and one unnumbered active regions on the visible disc. AR3141 in the east remains the largest, most active and complex group, classified as Eko/Beta-gamma. Some weak spots of mixed magnetic field appear to be developing in the intermediate portion of the group, a potential sign of increasing complexity. AR3140 in the northeast is the second largest region, with a moderately sized mature spot, Hsx/Alpha, but is inactive. The only other moderately sized unipolar spot is located in the far northwestern hemisphere, AR3135, an Hsx/Alpha group. All other spots are relatively small and simple at this time. No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: The solar wind, observed by DSCOVR at L1, has been generally slow-ambient with averages around 390km/s, and occasional increases to slightly elevated levels, with peaks around 400-420km/s. Density saw a steady increase from average to above average levels during much of the first half of the UTC day, before erratically decreasing back to near average levels after 07/1000 UTC. This is suspected to be due to the arrival of a slow CME at Earth. Total magnetic field strength, IMF, was initially weak, but steadily increased to become mainly moderate from around 07/0700 UTC. A brief strong interval was observed between 07/1630-07/1715 UTC, with a peak value of 15.7nT at 07/1655 UTC. The north-south component, Bz varied weakly at first, but strengthened and became predominantly moderately negative between 07/0930-1745 UTC, with a peak value of -14.6nT at 07/1656 UTC. In the latter part of the UTC day the Bz has been predominantly weak to moderate and positive. Phi angle has been mostly positive (away from the Sun). Geomagnetic activity was initially Quiet (Kp0-1) but increased to reach Minor Storm/G1 (Kp5) levels between 07/1500-2100 UTC, before easing back to Quiet levels (Kp2) in the most recent (07/2100-2400 UTC) interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has remained at background levels. High energy electron flux (greater than 2 MeV) at GOES-16 was at high levels initially, reaching a peak of 9.40e3 pfu at 07/0925UTC. Following the arrival of the CME, electron flux dramatically reduced, becoming predominantly background from 07/1640 UTC. Electron fluence levels have been above the Active threshold throughout, though with a slowly increasing then more rapidly declining trend. A value of 2.83e8 integrated pfu was observed at 08/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be generally Low, with a chance of Moderate activity.

Solar Wind / Geomagnetic Activity: Geomagnetic activity is expected to be mainly Quiet to Unsettled given generally slow-ambient solar winds, but there is a chance of Active intervals at times given any prolonged periods of negative Bz. There is a very slight chance of G1/Minor

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Storm intervals, mainly due to the possible arrival of one or more coronal hole high speed streams in the coming days.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) observed by GOES-16 is expected to be at background levels. High energy electron flux (greater than 2MeV) is expected to be at background to moderate levels for much of the period, possibly increasing to high levels at times of diurnal maxima. Electron fluence values will remain above the Active (1e8 integrated pfu) threshold initially, but soon drop below on day 1 (8th) and very likely to remain below in the coming days.

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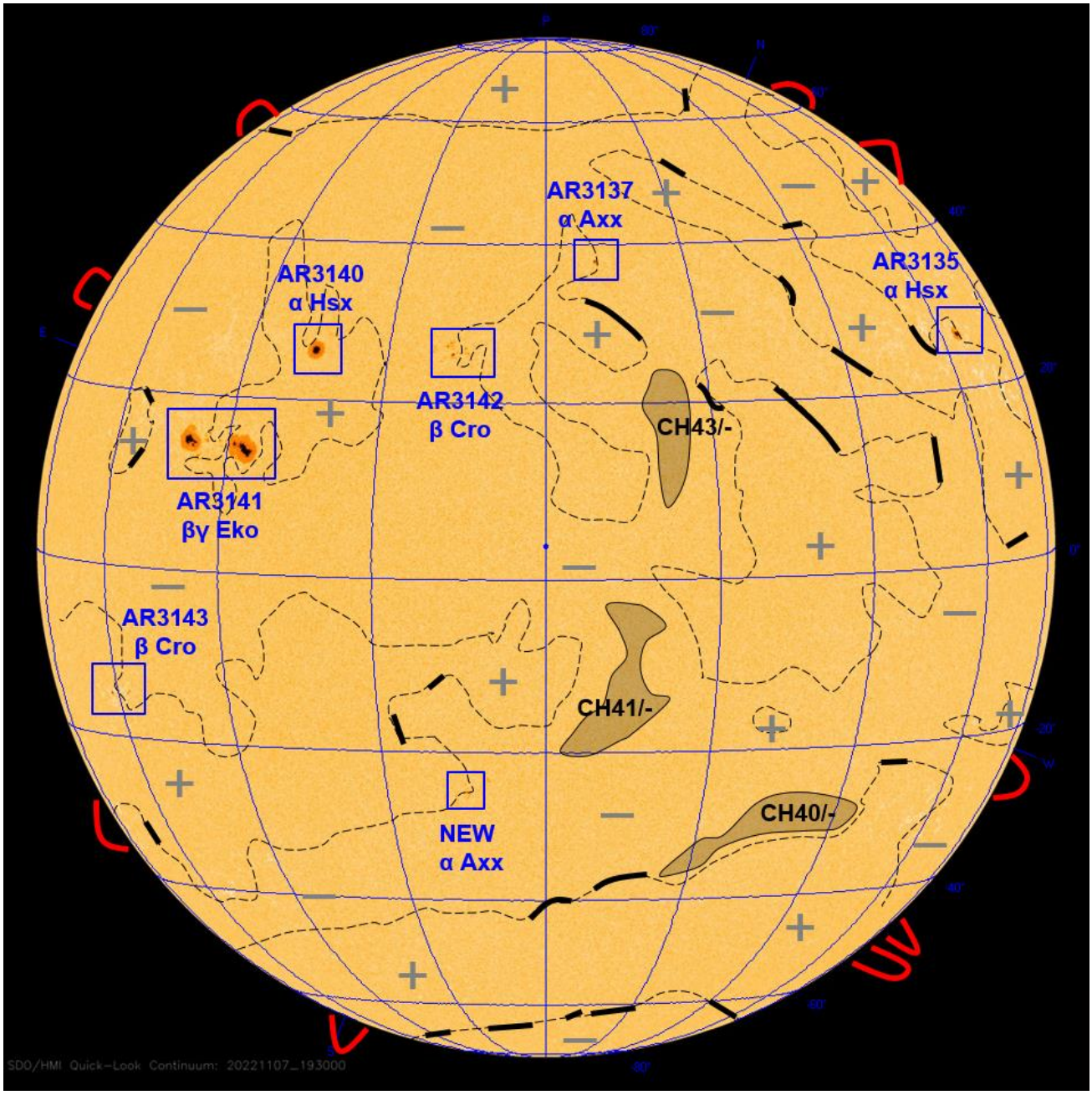
Figure 1. Solar Analysis Valid 07/1930 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth directed CMEs currently feature in the forecast. A large number of filaments are present on the Earth-facing disc and will be monitored for any potential lift-offs or eruptions.

Solar wind speeds are currently slow-ambient to slightly elevated, with speeds between 390-420km/s. Influence from the elongated Coronal hole 40 in the south of the disk may see an increase in speeds at times throughout the period as the leading edge becomes geoeffective, although there is low confidence in the strength of any connection. Indeed STEREO A has not apparently observed any connection to this feature so far. There is a greater likelihood that Earth may connect to coronal holes 41 or 43 later on day 2 or into day 3 (9th or 10th Nov). However any impact at the Earth is expected to be fairly limited due to their negative polarity as we slowly edge away from the autumn equinox.

Geomagnetic activity is expected to be mainly Quiet to Unsettled, with a chance of Active intervals at times given any prolonged periods of negative Bz. There is a very slight chance of G1/Minor Storm intervals either due to residual influence of the recent CME impact during day 1 (8th), or from the possible arrival of coronal hole high speed streams during days 2 and 3.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	10	10	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections – Nil

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Radio Blackouts - X-Ray Flares:

At the time of writing there are currently six numbered sunspot regions and one unnumbered group on the visible disc. The largest and most complex region AR3141 in the northeast was responsible for an M5 flare at 07/0011 UTC and numerous other C-class flares. This region possesses a beta-gamma configuration with evidence of some weak, mixed magnetic field spots in the intermediate portion of the group that could signify some development of the region. Two large unipolar spots are present in the northeast and far northwest, but both seem inactive. The remaining regions appear small and simple at this time.

STEREO-A EUVI imagery suggests a new bright region of flux will rotate over the eastern limb (at around 25-30S) late day 1 (8th) or early day 2 (9th). This area may contain one or more sunspot groups that could supplement the present risk of significant flares. Additionally two Strong Active Regions (SARs) recognised in the far hemisphere by the Strong Active Region Discriminator (SARD), are expected to reach the east limb early on day 3 (10th). This also may increase the risk for significant flares.

Solar activity has been Moderate, with several C-class flares observed in the past 24 hours, and at 07/0011UTC a single M-class flare was recorded originating from sunspot AR3141. Activity is expected to remain largely Low, but there is a chance throughout of further isolated M-class flares, most likely from AR3141.

There remains a very slight chance of isolated X-class flares and solar activity reaching High levels throughout the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	40	50	50
Very Active	R3 to R5 X Class	No	3	3	5	5

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Figure 2: AR3141 as viewed in HMI Intensitygram Flat Orange (left) and HMI Colorized Magnetogram (right) at 08/0000 UTC.

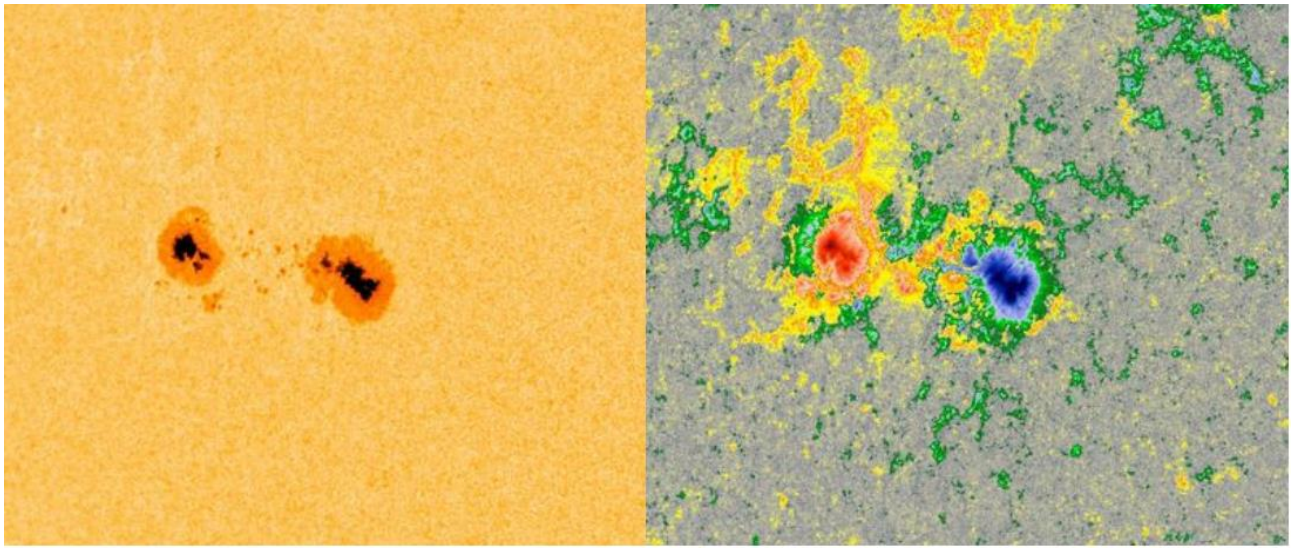
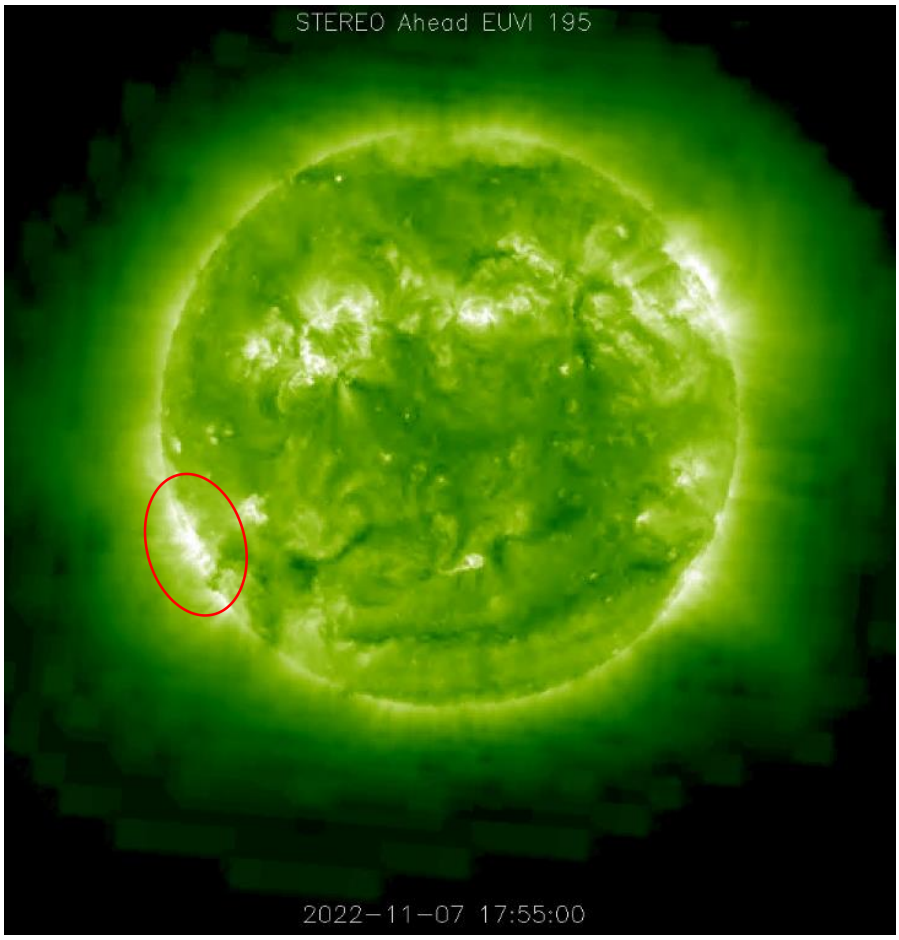


Figure 3: STEREO A EUVI 195 imagery at 07/1755 UTC. New bright flux region arriving at east limb highlighted in red circle.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) at GEO, observed by GOES-16 is currently at background levels and is forecast to remain at this level through the guidance period. A very minor increase in proton storm probabilities is included from day 2 (9th) as AR3141 moves into a slightly more 'connected' position relative to Earth.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) though initially high over the past 24 hours, dropped dramatically with the CME arrival on the 7th, significantly suppressing electron counts to background or moderate levels. Background to moderate levels are expected to be maintained for much of the period, possibly increasing to high levels at times of diurnal maxima.

Electron fluence values will be above the Active (1e8 integrated pfu) threshold initially, but soon drop below on day 1 (8th) and expected to remain below in the coming days. Confidence in this forecast is high initially. This lowers to moderate by the end of the period given uncertainties over the duration and strength of any geomagnetic activity resulting from one or more forecast high speed streams that are due to affect Earth.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	10	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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Figure 4: GOES-16 Electron Flux and MOSWOC REFM fluence observations and model.

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